

WHAT IS CLAIMED IS:

1. A method for manufacturing a semiconductor film, comprising the steps of:  
preparing a first member including a semiconductor substrate, a semiconductor layer, and a separation layer provided between the semiconductor substrate and the semiconductor layer;  
bonding or attracting a second member which is hardly heated by induction heating, onto the semiconductor layer of the first member; and  
separating the semiconductor layer from the semiconductor substrate at the separation layer by heating the semiconductor substrate by induction heating.
2. A method according to Claim 1, wherein said step for preparing the first member comprises a step of forming a porous silicon layer, serving as a separation layer, by anodizing a surface of a nonporous silicon substrate, and a step of forming a nonporous silicon layer on the porous silicon layer according to epitaxial growth.
3. A method according to Claim 1, wherein said step for preparing the first member comprises a step of forming an ion-implanted layer, serving as a separation layer, except for a silicon layer where ions are not implanted on a surface thereof, by implanting at least one type of ions selected from hydrogen, nitrogen and helium to a predetermined depth from a surface of a silicon substrate.
4. A method according to Claim 3, wherein said step for preparing the first member further comprises a step of forming a protective film on the surface of the silicon substrate before implanting the ions.
5. A method according to Claim 1, wherein said step of heating the semiconductor substrate by induction heating comprises a step of mounting the bonded or attracted first and second members on an induction-heating mount around which a coil is

6. A method according to Claim 1, further comprising a step of forming slits in the separation layer before heating the semiconductor substrate by induction heating.

8. A method according to Claim 1, wherein, in said step of heating the semiconductor substrate by induction heating, a pressure or a hydrostatic pressure by a fluid is simultaneously applied to the separation layer.

10. A method according to Claim 1, further comprising a step of removing a residue of the separation layer remaining on the semiconductor layer according to etching, after separating the semiconductor layer.

11. A method according to Claim 1, further comprising a step of reutilizing a remaining semiconductor substrate for preparing another first member, after separating the semiconductor layer.

12. A method according to Claim 11, further comprising a step of removing a residue of the separation layer remaining on the semiconductor substrate according to etching, before reutilizing the semiconductor substrate.

13. A method for manufacturing a semiconductor film comprising the steps of:

preparing a first member including a semiconductor substrate, a semiconductor layer, and a separation layer provided between the semiconductor substrate and the semiconductor layer;

bonding or attracting a second member whose resistivity is higher than a resistivity of the semiconductor substrate, onto the semiconductor layer of the first member; and

separating the semiconductor layer from the semiconductor substrate at the separation layer by heating the semiconductor substrate by induction heating.

14. A method according to Claim 13, wherein said step for preparing the first member comprises a step of forming a porous silicon layer, serving as a separation layer, by anodizing a surface of a nonporous silicon substrate, and a step of forming a nonporous silicon layer on the porous silicon layer according to epitaxial growth.

15. A method according to Claim 13, wherein said step for preparing the first member comprises a step of forming an ion-implanted layer, serving as a separation layer, except for a silicon layer where ions are not implanted on a surface thereof, by implanting at least one type of ions selected from hydrogen, nitrogen and helium to a predetermined depth from a surface of a silicon substrate.

16. A method according to Claim 15, wherein said step for preparing the first member further comprises a step of forming a protective film on the surface of the silicon substrate before implanting the ions.

17. A method according to Claim 13, wherein said step of heating the semiconductor substrate by induction heating comprises a step of mounting the bonded or attracted first and second members on an induction-heating mount around which a

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coil is wound, and causing a current to flow in the semiconductor substrate by supplying the coil with a high-frequency current.

18. A method according to Claim 13, further comprising a step of forming slits in the separation layer before heating the semiconductor substrate by induction heating.

19. A method according to Claim 13, wherein, in said step of heating the semiconductor substrate by induction heating, a tensile force, a compressive force or a shearing force is simultaneously applied to the separation layer.

20. A method according to Claim 13, wherein, in said step of heating the semiconductor substrate by induction heating, a pressure or a hydrostatic pressure by a fluid is simultaneously applied to the separation layer.

21. A method according to Claim 13, wherein, in said step of heating the semiconductor substrate by induction heating, the second member is simultaneously cooled.

22. A method according to Claim 13, further comprising a step of removing a residue of the separation layer remaining on the semiconductor layer according to etching, after separating the semiconductor layer.

23. A method according to Claim 13, further comprising a step of reutilizing a remaining semiconductor substrate for preparing another first member, after separating the semiconductor layer.

24. A method according to Claim 23, further comprising a step of removing a residue of the separation layer remaining on the semiconductor substrate according to etching, before reutilizing the semiconductor substrate.

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25. A method for manufacturing a semiconductor film comprising the steps of:  
preparing a first member including a semiconductor substrate, a semiconductor layer whose resistivity is higher than a resistivity of the semiconductor substrate, and a separation layer provided between the semiconductor substrate and the semiconductor layer; and  
separating the semiconductor layer from the semiconductor substrate at the separation layer by heating the first member by induction heating.
26. A method according to Claim 25, further comprising a step of bonding or attracting a second member which is hardly heated by induction heating, onto the semiconductor layer of the first member, before heating the first member by induction heating.
27. A method according to Claim 25, further comprising a step of bonding or attracting a second member whose resistivity is higher than a resistivity of the first member, onto the semiconductor layer of the first member, before heating the first member by induction heating.
28. A method according to Claim 25, wherein the resistivity of the semiconductor layer is at least 10 times the resistivity of the semiconductor substrate.
29. A method according to Claim 25, wherein the resistivity of the semiconductor layer is at least  $1 \Omega \cdot \text{cm}$ , and the resistivity of the semiconductor substrate is equal to or less than  $0.1 \Omega \cdot \text{cm}$ .
30. A method according to Claim 25, wherein said step for preparing the first member comprises a step of forming a porous silicon layer, serving as a separation layer, by anodizing a surface of a  $p^+$ -type nonporous silicon substrate, and a step of

31. A method according to Claim 25, wherein said step for preparing the first member comprises a step of forming a p<sup>-</sup>-type silicon layer on a p<sup>+</sup>-type silicon substrate according to epitaxial growth, and forming an ion-implanted layer, serving as a separation layer, except for a p<sup>-</sup>-type silicon layer where ions are not implanted on a surface thereof, by implanting at least one type of ions selected from hydrogen, nitrogen and helium to a predetermined depth from a surface of the p<sup>-</sup>-type silicon layer.

32. A method according to Claim 31, wherein said step of preparing the first member further comprises a step of forming a protective film on the surface of the p<sup>-</sup>-type silicon layer before implanting the ions.

33. A method according to Claim 25, wherein said step of heating the semiconductor substrate by induction heating comprises a step of mounting the first member on an induction-heating mount around which a coil is wound, and causing a current to flow in the semiconductor substrate by supplying the coil with a high-frequency current.

34. A method according to Claim 25, further comprising a step of forming slits in the separation layer before heating the first member by induction heating.

35. A method according to Claim 25, wherein, in said step of heating the first member by induction heating, a tensile force, a compressive force or a shearing force is simultaneously applied to the separation layer.



36. A method according to Claim 25, wherein, in said step of heating the first member by induction heating, a pressure or a hydrostatic pressure by a fluid is simultaneously applied to the separation layer.
37. A method according to Claim 25, further comprising a step of removing a residue of the separation layer remaining on the semiconductor layer according to etching, after separating the semiconductor layer.
38. A method according to Claim 25, further comprising a step of reutilizing a remaining semiconductor substrate for preparing another first member, after separating the semiconductor layer.
39. A method according to Claim 38, further comprising a step of removing a residue of the separation layer remaining on the semiconductor substrate according to etching, before reutilizing the semiconductor substrate.
40. A method for manufacturing a solar cell comprising the steps of:
  - forming a porous silicon layer by anodizing a surface of a  $p^+$ -type nonporous silicon substrate;
  - sequentially forming a  $p^-$ -type nonporous silicon layer and an  $n^+$ -type nonporous silicon layer on the porous silicon layer according to epitaxial growth;
  - attracting an attraction mount which is hardly heated by induction heating, on the  $n^+$ -type nonporous silicon layer;
  - separating the  $p^-$ -type and  $n^+$ -type nonporous silicon layers from the  $p^+$ -type nonporous silicon substrate at the porous silicon layer by heating the  $p^+$ -type nonporous silicon substrate by induction heating; and
  - forming electrodes on the separated  $p^-$ -type and  $n^+$ -type nonporous silicon layers.

41. A method according to Claim 40, wherein said step of heating the  $p^+$ -type nonporous silicon substrate by induction heating comprises a step of mounting the  $p^+$ -type nonporous silicon substrate attracted on the attraction mount on an induction-heating mount around which a coil is wound, and causing a current to flow in the  $p^+$ -type nonporous silicon substrate by supplying the coil with a high-frequency current.
42. A method according to Claim 41, wherein, in said step of heating the  $p^+$ -type nonporous silicon substrate by induction heating, the attraction mount is simultaneously cooled.
43. A method according to Claim 40, further comprising a step of removing a residue of the porous silicon layer remaining on the  $p^-$ -type nonporous silicon layer, before forming electrodes after separating the  $p^-$ -type and  $n^+$ -type nonporous silicon layers from the  $p^+$ -type nonporous silicon substrate.
44. A method according to Claim 40, wherein said step of forming the electrodes comprises a step of performing heat welding of a surface of the  $p^-$ -type nonporous silicon layer onto an aluminum plate and simultaneously forming a  $p^+$ -type nonporous silicon layer by diffusing aluminum into the  $p^-$ -type nonporous silicon layer, and a step of forming collecting electrodes on the surface of the  $n^+$ -type nonporous silicon layer.
45. A method according to Claim 44, further comprising a step of forming an antireflection layer on the  $n^+$ -type nonporous silicon layer on which the collecting electrodes are formed.
46. A method according to Claim 40, wherein the  $p^-$ -type and  $n^+$ -type nonporous silicon layers are formed according to liquid deposition.

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47. A method according to Claim 40, further comprising a step of reutilizing a remaining  $p^+$ -type nonporous silicon substrate for manufacturing another solar cell, after separating the  $p^-$ -type and  $n^+$ -type nonporous silicon layers.

48. A method according to Claim 47, further comprising a step of removing a residue of the porous silicon layer remaining on the  $p^+$ -type nonporous silicon substrate, before reutilizing the  $p^+$ -type nonporous silicon substrate.

49. A method for manufacturing an SOI (silicon-on-insulator) substrate comprising the steps of:

forming a porous silicon layer by anodizing a surface of a  $p^+$ -type nonporous silicon substrate;

forming a  $p^-$ -type nonporous silicon layer on the porous silicon layer according to epitaxial growth;

forming a silicon-oxide layer on the surface of the  $p^-$ -type nonporous silicon layer;

forming a multilayer structure by bonding another nonporous silicon substrate on a surface of the silicon-oxide layer; and

separating the  $p^-$ -type nonporous silicon layer from the  $p^+$ -type nonporous silicon substrate at the porous silicon layer by heating the multilayer structure by induction heating.

50. A method according to Claim 49, further comprising a step of attracting an attraction mount which is hardly heated by induction heating onto the multilayer structure, before heating the multilayer structure by induction heating.

51. A method according to Claim 50, wherein, in said step of heating the multilayer structure by induction heating, the attraction mount is simultaneously cooled.

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52. A method according to Claim 49, wherein said step of heating the multilayer structure by induction heating comprises a step of mounting the multilayer structure on an induction-heating mount around which a coil is wound, and causing a current to flow in the  $p^+$ -type nonporous silicon substrate by supplying the coil with a high-frequency current.

53. A method according to Claim 49, further comprising a step of removing a residue of the porous silicon layer remaining on the  $p^-$ -type nonporous silicon layer by etching, after separating the  $p^-$ -type nonporous silicon layer from the  $p^+$ -type nonporous silicon substrate.

54. A method according to Claim 53, further comprising a step of smoothing the surface of the  $p^-$ -type nonporous silicon layer by performing annealing in a reductive-gas atmosphere after removing the residue of the porous silicon layer.

55. A method according to Claim 49, further comprising a step of performing thermal oxidation of inner walls of the porous silicon layer before forming the  $p^-$ -type nonporous silicon layer on the porous silicon layer according to epitaxial growth, and a step of smoothing the surface of the porous silicon layer by performing heat treatment in a hydrogen atmosphere.

56. A method according to Claim 49, wherein the  $p^-$ -type nonporous silicon layer is formed according to chemical vapor deposition (CVD).

57. A method according to Claim 49, further comprising a step of reutilizing a remaining  $p^+$ -type nonporous silicon substrate for manufacturing another SOI substrate, after separating the  $p$ -type nonporous silicon layer.

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58. A method according to Claim 57, further comprising a step of removing a residue of the porous silicon layer remaining on the  $p^+$ -type nonporous silicon substrate, before reutilizing the  $p^+$ -type nonporous silicon substrate.

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